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Indian Standard

SPECIFICATION FOR FIXED METALLIZED POLYPROPYLENE FILM DIELECTRIC CAPACITORS

PART 1 GENERAL REQUIREMENTS AND METHODS OF TESTS

UDC 621·319·4 : 621·315·616·96-416 : 678·742·3 : 621·38·038

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6

November 1984

Indian Standard

SPECIFICATION FOR FIXED METALLIZED POLYPROPYLENE FILM DIELECTRIC CAPACITORS

PART 1 GENERAL REQUIREMENTS AND METHODS OF TESTS

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Indian Standard

SPECIFICATION FOR FIXED METALLIZED POLYPROPYLENE FILM DIELECTRIC CAPACITORS

PART 1 GENERAL REQUIREMENTS AND METHODS OF TESTS

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Indian Standards Institution on 12 June 1984, after the draft finalized by the Capacitors Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard is expected to establish uniform requirements for judging the mechanical, electrical and climatic properties of fixed metallized polypropylene film dielectric capacitors intended to be used in electronic and telecommunication equipment.

0.3 This standard requires reference to IS : 7305-1984*, covering details of various prescribed tests. Only the appropriate degree of severity and any other special conditions relating to certain tests have been included in this standard.

0.4 The capacitors covered by this standard are mainly intended for use with dc voltage. Capacitors for use with ac voltage and for pulse application would be covered by separate standard.

0.5 This standard is largely based on IEC Pub 384-16 Fixed capacitors for use in electronic equipment Part 16 Sectional specification: Fixed metallized polypropylene film dielectric dc capacitors, issued by the International Electrotechnical Commission (IEC).

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 1) applies to fixed capacitors with metallized electrodes and polypropylene dielectric for use in electronics and similar general applications.

1.1.1 The maximum power to be applied is 500 VAR at 50 Hz and maximum peak voltage is 2 500 V.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 7305-1984* shall apply.

3. DESCRIPTION AND CODE

3.1 The description of the type of capacitors shall be in the form of a four Character Code.

Example — FCPP 1

' FC ' denotes fixed capacitor;

' PP ' denotes polypropylene; and

' 1 ' denotes a particular type of capacitor.

4. CLIMATIC CATEGORIES

4.1 The severities for the cold, dry heat and damp heat steady state tests for the capacitors covered by this standard shall be within the following ranges:

Lower category temperature	—55° C to —10° C
Upper category temperature	+70° C to +100° C
Damp heat, steady state	04 to 56 days

4.1.1 Values selected within these ranges shall be chosen from those listed in IS : 9000 (Part 1)-1977†. The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

NOTE — The preferred climatic categories are:

Category 1A	55/100/56
Category 1B	55/085/56
Category 2	40/085/21

5. RATINGS

5.1 Rated Capacitance (C_R) — The preferred values of rated capacitance are values chosen from the *E* series of preferred values given in IS : 824-1965‡.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

†Basic environmental testing procedures for electronic and electrical items: Part 1 General.

‡Preferred values for resistors and capacitors (*revised*).

5.2 Tolerance on Rated Capacitance – The preferred tolerances on the rated capacitance are:

± 20, ± 10, ± 5, ± 2 and ± 1 percent

5.3 Rated Capacitance with Associated Tolerance Values — The preferred combimation of capacitance series and tolerances are as given below:

Series	*Tolerance* Percent
E 6	± 20
E12	± 10
E24	± 5
E48	± 2
E96	± 1

5.4 Rated Voltage (U_R) — The preferred values of rated voltage are the values of the $R5$ series given in IS : 1076-1967*:

100, 160, 250, 400, 630, 1 000, 1 600, 2 000 and 2 500 V

NOTE 1 — 2 000 V is not a preferred value but has been included due to its common usage.

NOTE 2 — The sum of the dc voltage and the peak ac voltage applied to the capacitor shall not exceed the rated voltage. Unless specified otherwise the value of the peak ac voltage shall not exceed the following rated voltage at the frequencies stated:

	percent
50 Hz	20
100 Hz	15
1 kHz	3
10 kHz	1

5.5 Category Voltage (U_C) — The category voltage is equal to the rated voltage U_R for upper category temperature up to 85°C. At an upper category temperature of 100°C the category voltage is 0·8 U_R.

5.6 Rated Temperature — For upper category temperature $\geqslant$85°C the rated temperature is 85°C and for an upper category temperature $<$85°C the rated temperature is equal to the upper category temperature.

6. CONSTRUCTION AND WORKMANSHIP

6.1 The construction, finish and workmanship shall be in accordance with **6** of IS : 7305-1984†.

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*Specification for preferred numbers (*first revision*).

†Specification for fixed capacitors used in electronic equipment (*first revision*).

7. MARKING

7.1 The following information in the order given below is required:

a) Rated capacitance (*see* the code given in IS : 8186-1976*),
b) Tolerance on rated capacitance (*see* the code given in IS : 8186-1976*),
c) Rated voltage (dc voltage may be indicated by the symbol ⎓ or ——),
d) Category voltage (if different from the rated voltage),
e) Year and month (or week) of manufacture (*see* the code given in IS : 8186-1976*),
f) Description and code,
g) Manufacturer's name or trade mark,
h) Climatic category, and
j) Manufacturers's type designation.

7.2 The capacitor shall be clearly marked with **7.1**(a), **7.1**(b) and **7.1**(c) above and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the capacitor shall be avoided.

7.3 The package containing the capacitor(s) shall be clearly marked with all the information listed in **7.1**.

7.4 Any additional marking shall be so applied that no confusion should arise.

7.5 The capacitors or its packages may be marked with the ISI Certification Mark also.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors may be obtained from the Indian Standards Institution.

8. TESTS

8.1 Classification of Tests

8.1.1 *Type Tests*

8.1.1.1 *Type approval procedure* — The procedure for type approval shall be in accordance with IS : 2612-1965†.

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*Marking codes for values and tolerances of resistors and capacitors.

†Recommendation for type approval and sampling procedures for electronic components.

8.1.1.2 *Number of samples* — The manufacturer shall submit 34 samples of the highest capacitance value in the smallest case size and 34 samples of the lowest capacitance value in the largest case size, within a single voltage rating for which approval is desired, in accordance with Table 1.

8.1.1.3 *Schedule of type tests* — The capacitors shall be subjected to the tests specified in Table 1, in the given order. After the completion of the tests specified in Group 0, the samples shall be divided into seven groups for further testing.

NOTE — A capacitor subjected to type tests according to Table 1, or to any part of them which may be considered destructive, shall *not* be used in the equipment nor be returned to the bulk supply.

TABLE 1 SCHEDULE OF TYPE TESTS

(*Clauses* 8.1.1.2 *and* 8.1.1.3)

GROUP	NUMBER OF SAMPLES EACH VOLTAGE RATING		TEST
	Smallest Case Size	Largest Case Size	
(1)	(2)	(3)	(4)
0	34	34	Visual examination (*see* **8.4.1**) Dimensions (*see* **8.4.2**) Capacitance (*see* **8.3.2**) Tangent of loss angle (*see* **8.3.3**) Outer foil marking (*see* **8.3.5**) Inductance (*see* **8.3.6**) Voltage proof (*see* **8.3.1**) Insulation resistance (*see* **8.3.4**) Sealing (*see* **9.1**)
1	6	6	Solderability (*see* **8.4.4.1**) Robustness of terminations (*see* **8.4.3**) Bump (*see* **8.4.6**) Vibration (*see* **8.4.5**) Shock (**8.4.7**) Acceleration (steady state) (*see* **8.4.8**) Rapid change of temperature (**8.5.3**) Climatic sequence (*see* **8.5.1**)
2	6	6	Damp heat (steady state) (*see* **8.5.2**) Storage at low temperature (*see* **9.5**)
3	8	8	Endurance (electrical) (*see* **9.2**)
4	4	4	Self healing (*see* **8.3.7**)
5	2	2	Mould growth (*see* **8.5.4**)
6	3	3	Resistance to solvents (*see* **9.3**) Resistance to soldering heat (*see* **8.4.4.2**) Resistance to steam (*see* **9.4**)
7	3	3	Salt mist (*see* **8.5.5**)
Spares	2	2	

8.1.2 *Routine Tests* — The following tests shall be done on each and every capacitor:

a) Visual examination,
b) Voltage proof (two seconds duration), and
c) Capacitance.

8.1.3 *Acceptance Tests* — From the lot which has passed routine tests, two groups of samples (Group A and B) shall be selected and the capacitors in each group subjected to the tests specified in Table 2 in the order given:

TABLE 2 SCHEDULE OF ACCEPTANCE TESTS

TEST (1)	AQL (PERCENT DEFECTIVE) (2)	INSPECTION* LEVEL (3)
GROUP A		
Dimensions (*see* **8.4.2**)	1	II
Tangent of loss angle (*see* **8.3.3**)		
Outer foil marking (*see* **8.3.5**)		
Insulation resistance (*see* **8.3.4**)		
Sealing (*see* **9.1**)		
GROUP B		
Sub-group B1		
Resistance to solvents (*see* **9.3**)	4	S3 (Destructive)
Solderability (*see* **8.4.4.1**)		
Robustness of terminations (*see* **8.4.3**)		
Bump (*see* **8.4.6**)		
Climatic sequence (*see* **8.5.1**)		
Sub-group B2		
Endurance (electrical) 168(b) (*see* **9.2**)	4	S3 (Non-destructive)

**See* IS : 10673-1983 Sampling plans and procedures for inspection by attributes for electronic items.

8.2 General Conditions for Tests — The general conditions for tests shall be as specified in **8.2** of IS : 7305-1984*.

8.3 Electrical Tests

8.3.1 *Voltage Proof* — This test shall be carried out in accordance with **8.3.1** of IS : 7305-1984* with the details given in **8.3.1.1** and **8.3.1.2.**

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

8.3.1.1 *Test circuit* — After deleting the capacitor C_1, the product of R_1 and the capacitance C_x shall be less than or equal to 1 s and greater than 0·01 s. R_1 includes the internal resistance of the power supply and R_2 limits the discharge current to smaller than or equal to 1A or any other lower value specified in the relevant detail specification.

8.3.1.2 The following voltages shall be applied for a period of 1 min between the measuring points of Table 1 in **8.3.1.5** of IS : 7305-1984*.

Test Point	*Test Voltage*
1A	1·5 U_R
1B, 1C	2 U_R with a minimum of 400 V

8.3.2 *Capacitance* — This test shall be carried out in accordance with **8.3.2** of IS : 7305-1984*.

8.3.2.1 The capacitance shall be measured at, or corrected to, a frequency of 1 kHz. For capacitor of rated value >1 μf, 100 Hz may be used. The applied peak voltage at 1 kHz shall not exceed 3 percent of the rated voltage and the applied peak voltage at 100 Hz shall not exceed 100 V (70 V rms).

8.3.2.2 The capacitance shall be within the specified tolerance.

8.3.3 *Tangent of Loss Angle* — This test shall be carried out in accordance with **8.3.3** of IS : 7305-1984*.

8.3.3.1 *Requirement* — Tan δ shall not exceed 0·002 for category 1A and 1B and 0·004 for category 2.

8.3.4 *Insulation Resistance* — This test shall be carried out in accordance with **8.3.6** of IS : 7305-1984*, the details being given in **8.3.4.1** to **8.3.4.4**.

8.3.4.1 Before the measurement the capacitor shall be fully discharged. The product of the resistance of the discharge circuit and the rated capacitance of the capacitor under test shall be $\geqslant 0{\cdot}01$ s unless otherwise prescribed in the detail specification.

8.3.4.2 The measuring voltage shall be in accordance with **8.3.6.2** of IS : 7305-1984*. The voltage shall be applied immediately at the correct value through the internal resistance of the voltage source. The product of the internal resistance and the rated capacitance of the capacitor shall be smaller than 1 s unless otherwise prescribed in the detail specification.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

8.3.4.3 *Requirements* — Unless otherwise specified, the insulation resistance shall meet the following requirements:

MINIMUM *RC* PRODUCT (R = INSULATION RESISTANCE BETWEEN THE TERMINATIONS) (C = RATED CAPACITANCE) (s)		MINIMUM INSULATION RESISTANCE BETWEEN THE TERMINATIONS (G Ω)		MINIMUM INSULATION RESISTANCE BETWEEN TERMINATIONS AND CASE (G Ω)
Measuring points in accordance with Table 1 in **8.3.1.5** of IS : 7305-1984*				
1 (a)		1 (a)		1 (b) 1 (c) 1 (d)
Rated capacitance:				
$> 0{\cdot}33\ \mu f$		$\leqslant 0{\cdot}33\ \mu f$		
Rated voltage:				
> 100 V	$\leqslant 100$ V	> 100 V	$\leqslant 100$ V	
30 000	15 000	100	50	100

8.3.4.4 When the test is made at a temperature other than 25°C, the result shall be corrected to 25°C by multiplying the result of the measurement by the appropriate correction factor. In case of doubt, measurement at 25°C is decisive. The following correction factors may be considered as an average for metallized polypropylene film capacitors:

Temperature (°C)	*Correction Factor*
15	0·25
20	0·50
23	0·75
25	1·00
27	1·25
30	1·50
35	1·75

This table is based on the formula:

$$R_{25} = R_t \times 2^{\left(\frac{t-25}{25}\right)}$$

where

R_{25} = Insulation resistance at 25°C, and

R_t = Insulation resistance at temperature t°C.

8.3.5 *Outer Foil Marking* — This test shall be carried out in accordance with **8.3.8** of IS : 7305-1984*.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

8.3.6 *Inductance* — This test shall be carried out in accordance with **8.3.7** of IS : 7305-1984*.

8.3.7 *Self Healing* — This test shall be carried out in accordance with **8.3.11** of IS : 7305-1984*.

8.4 Physical and Mechanical Tests

8.4.1 *Visual Examination* — The capacitors shall be visually examined for the requirements of making and finish.

8.4.2 *Dimensions* — The dimensions shall be checked for compliance with those specified in the relevant specification.

8.4.3 *Robustness of Terminations* — This test shall be carried out in accordance with **8.4.4** of IS : 7305-1984*.

8.4.4 *Soldering*

8.4.4.1 *Solderability* — Unless otherwise prescribed in the detail specification the capacitors shall be subjected to this test in accordance with **8.4.5.1** of IS : 7305-1984* using either the 'solder-globule method' or the 'solder-bath method', with the following deviations:

a) The wire terminations stated by the manufacturer to be suitable for use with printed wiring shall be immersed up to $2.0^{+0.5}_{-0.0}$ mm from the body with a suitable heat shield, which will simulate a printed wiring board;

b) The requirements for the solder-globule method shall be prescribed in the detail specification; and

c) Where neither the solder-bath nor the solder-globule method is appropriate, the soldering iron test shall be used with soldering iron size A.

NOTE — The thermal shock test is not applicable.

8.4.4.2 *Resistance to soldering heat* — Unless otherwise specified, this test shall be carried out in accordance with **8.4.5.2** of IS : 7308-1984* without any predrying.

Depth of immersion — The distance between the point of emergence of the terminations and the capacitor body shall be $2{\cdot}0^{+0.5}_{-0.0}$ mm for capacitors intended for printed wiring applications and $3{\cdot}5^{+0.5}_{-0.0}$ mm for capacitors intended for other applications.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

Final requirements — The capacitors shall meet the following requirements:

Test	*Requirements*
Visual examination (*see* **8.4.1**)	There shall be no visible damage.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 2 percent.
Tan δ (*see* **8.3.3**)	The increase in tan δ with respect to its value measured in **8.3.3.1** shall not exceed 0·002.
Insulation resistance (*see* **8.3.4**)	As given in **8.3.4.3.**

8.4.5 *Vibration* — This test shall be carried out in accordance with **8.4.6** of IS : 7305-1984* with the following details:

8.4.5.1 The severities shall be as specified in the relevant detail specification chosen from the following:

Frequency Hz	*Peak Value of Vibration Amplitude* ± 10 *percent*	*Duration*	*Category*
10 to 2 000	0·75 mm or 200 m/s² whichever is less	12 h	1A
10 to 2 000	0·75 mm or 100 m/s² whichever is less	9 h	1B
10 to 500	0·75 mm or 100 m/s² whichever is less	6 h	2

8.4.5.2 When specified in the detail specification during the last 30 min of the vibration test in each direction of movement, an electrical measurement shall be made to determine intermittent contact for open or short circuit. The duration of measurement shall be the time needed for one sweep of the frequency range from one frequency extreme to the other.

8.4.5.3 Where specified in the detail specification, when capacitors are tested as specified above, there shall be no intermittent contacts of greater than or equal to 0·5 ms, nor open or short circuit and no visible damage.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

8.4.5.4 *Final requirements* — The capacitors shall meet the following requirements:

Test	*Requirements*
Visual examination (*see* **8.4.1**)	There shall be no visible damage.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 2 percent.
Tan δ (*see* **8.3.3**)	The increase in tan δ with respect to its value obtained in **8.3.3.1** shall not exceed 1·1 percent.
Insulation resistance (*see* **8.3.4**)	As given in **8.3.4.3**.

8.4.6 *Bump* — This test shall be carried out in accordance with **8.4.7** of IS : 7305-1984* with the following details:

8.4.6.1 No initial measurements have to be made. The severity and method of mounting shall be given in the detail specification.

8.4.6.2 *Final requirements* — The capacitors shall meet the following requirements:

Test	*Requirements*
Visual examination (*see* **8.4.1**)	There shall be no visible damage.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 2·0 percent.
Tan δ (*see* **8.3.3**)	The increase of Tan δ with respect to its value measured in **8.3.3.1** shall not exceed 1·1 percent.
Insulation resistance (*see* **8.3.4**)	As in **8.3.4.3**.

8.4.7 *Shock* —This test shall be carried out in accordance with **8.4.8** of IS : 7305-1984* with the following details:

8.4.7.1 No initial measurements have to be made. The severity and method of mounting shall be given in the detail specification.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

8.4.7.2 *Final requirements* — The capacitors shall meet the following requirements:

Test	*Requirements*
Visual inspection (*see* **8.4.1**)	There shall be no visible damage.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 2·0 percent.
Tan δ (*see* **8.3.3**)	The increase of tan δ with respect to its value measured in **8.3.3.1** shall not exceed 1·1 percent.
Insulation resistance (*see* **8.3.4**)	As given in **8.3.4.3**.

8.4.8 *Acceleration* — This test shall be carried out in accordance with **8.4.9** of IS : 7305-1984*.

Method of mounting and degree of severity shall be as specified in the relevant specification.

8.4.8.1 *Final requirements* — The capacitors shall meet the requirements as follows:

Test	*Requirements*
Visual inspection (*see* **8.4.1**)	There shall be no visible damage.
Capacitance (*see* **8.3.2**)	The difference between the capacitances measured finally and in **8.3.2** shall not exceed 2.0 percent.
Tan δ (*see* **8.3.3**)	The increase of tan δ with respect to its value measured in **8.3.3.1** shall not exceed 1·1 percent.
Insulation resistance (*see* **8.3.4**)	As given in **8.3.4.3**.

8.5 Climate Tests

8.5.1 *Climatic Sequence* — This test shall be carried out in accordance with **8.5.1** of IS : 7305-1984* with the following details:

8.5.1.1 *Initial measurements* — No initial measurements have to be made.

8.5.1.2 *Dry heat* — This test shall be carried out in accordance with **8.5.1.2** of IS : 7305-1984* with the following details:

a) Duration : 16 h.

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

b) While still at the high temperature and at the end of the period of high temperature, the capacitance shall be measured. For category 1A and 1B capacitors the insulation resistance shall be measured and shall meet the following requirements:

Upper Category Temperature	Minimum *RC* Product (*R* = Insulation Resistance Between the Terminations) (*C* = Rated Capacitance) (S)		Minimum Insulation Resistance Between the Terminations (M Ω)		Minimum Insulation Resistance Between Termination and Case (M Ω)
	Measuring points in accordance with Table 1 under **8.3.1.5** of IS : 7305-1984*				
	1(a)		1(a)		1(b)
	Rated Capacitance: > 0·33 p*f*		$\leqslant$ 0·33 p*f*		
	Rated Voltage: > 100 V	$\leqslant$ 100 V	> 100 V	$\leqslant$ 100 V	
100°C	750	375	2 500	1 250	2 500
85°C	1 500	750	5 000	2 500	5 000
70°C	1 500	750	5 000	2 500	5 000

c) The percentage difference between the capacitance measured at the high temperature and in **8.4.4.2** or **8.4.6.2** or **8.4.7.2** as applicable shall meet the following requirements:

Test Temperature °C	*Maximum Percentage Difference in Capacitance*
70	– 2·5
89	– 3·25
100	– 4

8.5.1.3 *Damp heat (cyclic) first cycle* — This test shall be carried out in accordance with **8.5.1.3** of IS : 7305-1984* with the rated voltage applied.

After recovery the capacitors shall be visually examined. There shall be no visible damage and marking shall be legible.

8.5.1.4 *Cold* — This test shall be carried out in accordance with **8.5.1.4** of IS : 7305-1984* with the following details:

a) Duration : 2 h.

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b) Prior to the test the capacitance shall be measured under standard atmospheric conditions for testing.

c) While still at the specified low temperature and at the end of the period of low temperature the capacitance shall be measured. The percentage difference between the capacitance measured here and at (b) above shall meet the following requirements:

Test Temperature °C	*Maximum Percentage Difference in Capacitance*
− 55	+ 3·75
− 40	+ 3
− 25	+ 2·25

8.5.1.5 *Low air pressure* — This test shall be carried out in accordance with **8.5.1.5** of IS : 7305-1984* with the following details:

a) The test shall be made (when required by the detail specification) at a temperature of 15 to 35 °C and a pressure of 85 m bar. The duration of the test shall be 5 min.

b) While still at the specified low pressure and during the last minute of the five-minute period, the rated voltage shall be applied. The sample part of capacitors submitted to this test shall be subdivided into two or three sub-parts as necessary and each part submitted to one of the tests laid down under A and B in Table 1 of **8.3.1.5** of IS : 7305-1984*. The test voltage shall be applied to terminations, case, etc, as given in **8.3.1.2**.

c) During and after the test there shall be no evidence of permanent breakdown, flashover, harmful deformation of the case or seepage of impregnant.

8.5.1.6 *Damp heat* (*cyclic*) *remaining cycles* — This test shall be carried out in accordance with **8.5.1.6** of IS : 7305-1984* with the following details:

Within 15 min after removal from the damp heat test, the rated voltage shall be applied for one minute at test point A using the test circuit conditions given in **8.3.1.**

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8.5.1.7 *Final measurements and requirements* — After recovery the capacitors shall meet the following requirements:

Test	*Requirements*
Visual examination (*see* **8.4.1**)	There shall be no visible damage. The marking shall be legible.
Voltage proof (*see* **8.3.1**)	There shall be no spark or flashover.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 3 percent.
Tan δ (*see* **8.3.3**)	The increase in tan δ with respect to its value measured in **8.3.3** shall not exceed 0·003.
Insulation resistance (*see* **8.3.4**)	The insulation resistance shall not be less than 50 percent of the applicable values in **8.3.4.3**.

8.5.2 *Damp Heat (Steady State)* — This test shall be carried out in accordance with **8.5.2** of IS : 7305-1984* with details given in **8.5.2.1** to **8.5.2.3**.

8.5.2.1 *Initial measurement* — No initial measurements have to be made.

8.5.2.2 Within 15 min after removal from the damp heat test, the voltage proof test according to **8.3.1** shall be carried out, but with the rated voltage applied.

8.5.2.3 *Final measurements and requirements* — Within 2 h after recovery the capacitors shall be measured and shall meet the following requirements:

Test	*Requirements*
Visual examination (*see* **8.4.1**)	There shall be no visible damage. The marking shall be legible.
Voltage proof (*see* **8.3.1**)	There shall be no spark or flashover.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and its value obtained in **8.3.2** shall not exceed 3 percent for Category 1A & 1B and 5 percent for Category 2 capacitors.

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Test	*Requirements*
Tan δ (*see* **8.3.3**)	The increase in tan δ with respect to its value measured in **8.3.3.1** shall not exceed 0·003 for category 1A & 1B and 0·005 for Category 2.
Insulation resistance (*see* **8.3.4**)	The insulation resistance shall not be less than 50 percent of the applicable values in **8.3.4.3**.

8.5.3 *Rapid Change of Temperature* — This test shall be carried out in accordance with **8.5.3** of IS : 7305-1984*.

Number of cycles : 5.

Duration of exposure at the temperature limits — 30 min or longer if specified in the detail specification.

8.5.4 *Mould Growth* — This test shall be carried out in accordance with **8.8** of IS : 7305-1984*. There shall be no mould growth.

8.5.5 *Salt Mist* — This test shall be carried out in accordance with **7.9** of IS : 7305-1984*. The duration of the exposure shall be 4 days. There shall be no corrosion.

9. MISCELLANEOUS TESTS

9.1 Sealing — This test shall be carried out in accordance with **8.10** of IS : 7305-1984*.

9.2 Endurance — This test shall be carried out in accordance with **8.6** of IS : 7305-1984* with the following details:

9.2.1 *Initial Measurement* — 1 *μf* capacitors with rated capacitance tan δ shall be measured.

9.2.2 The duration of the test shall be 2 000 h for category 1A and 1B and 1 000 h for category 2.

9.2.3 Test voltage and temperature:

Category	[085]	[100]	
Temperature	85°C	100°C	85°C
Voltage	U_R	0·7 U_R	U_R
Sample part divided into	1 part	2 parts	

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*Specification for fixed capacitors used in electronic equipment (*first revision*).

The test voltage shall be applied to each capacitor individually through a resistor whose value R is equal to $\frac{0{\cdot}022}{C_R}$, where C_R is the rated capacitance in farads and R is the resistance in ohms, and shall be within 30 percent of the calculated value with a maximum of 2 mΩ.

9.2.4 After the specified period, the capacitors shall be allowed to cool to standard atmospheric conditions for testing and shall then be discharged across a resistor R such that the RC product is equal to or greater than 220 µs.

9.2.5 *Final Inspection, Measurements and Requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Requirements*
Visual inspection (*see* **8.4.1**)	There shall be no visible damage.
Voltage proof (*see* **8.3.1**)	There shall be no damage, spark or flashover.
Capacitance (*see* **8.3.2**)	The difference between the capacitance measured finally and in **8.3.2** shall not exceed 3 percent.
Tan δ (*see* **8.3.3**)	The increase in value of tan δ from that recorded in **8.3.3.1** shall not exceed 0·003.
Insulation resistance (*see* **8.3.4**)	The insulation resistance shall not be less than 50 percent of the value in **8.3.4.3**.

9.3 Resistance to Solvents — This test shall be carried out in accordance with **8.11** of IS : 7305-1984*.

9.4 Resistance to Steam (Applicable only to non-hermetically sealed type only) — This test shall be carried out in accordance with **8.12** of IS : 7305-1984*.

9.4.1 The capacitors shall be exposed to a saturated steam atmosphere of 35 kPa (gauge pressure) for a period of 90 min. The terminals shall not be welded, soldered or disfigured.

9.4.2 There shall be no evidence of unwrapping of the capacitor case or sleeve or other damage to the case.

9.5 Storage at Low Temperature — This test shall be carried out in accordance with **8.7.2** of IS : 7305-1984* at the minimum temperature of temperature severity for 48 ± 4 h.

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9.5.1 The capacitors shall be mounted by their normal means.

9.5.2 Throughout the test, rated voltage shall be applied across the terminations. There shall be no breakdown or flashover.

9.5.3 After the voltage has been removed and the capacitors have reached thermal equilibrium, the capacitors shall be visually examined. There shall be no damage and the marking shall be legible. The capacitance shall then be measured and meet the limits as specified in the detail specification.

(*Continued from page* 2)

Members	*Representing*
SHRI N. V. PAI	Bharat Capacitors, Hyderabad
SHRI M. S. MURTHY (*Alternate*)	
SHRI S. K. PANDEY	Electronics Components Standardization Organization (LCSO), Bangalore
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SHRI K. THAMPAN	Keltron Components Complex Ltd, Trivandrum

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	***Unit***	***Symbol***
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2